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EARL LIMPP DAM

HOLT COUNTY, MISSOURI

MO. 10508

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# PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



United States Army  
Corps of Engineers

... Serving the Army  
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
	AD-A105537	
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Earl Limpp Lake Dam (MO 10508) Holt County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Hoskins-Western-Sonderegger, Inc.		8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0046
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE May 1979
		13. NUMBER OF PAGES Approximately 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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HOLT COUNTY, MISSOURI

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PHASE I INSPECTION REPORT

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NATIONAL DAM SAFETY PROGRAM.

Earl Limpp Dam (MO 10508),  
Missouri - Nemaha - Nodaway Basin,  
Holt County, Missouri. Phase I Inspection  
Report.

PREPARED BY  
HOSKINS-WESTERN-SONDEREGGER, INC.  
CONSULTING ENGINEERS  
LINCOLN, NEBRASKA

UNDER DIRECTION OF  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

11 MAY 1979

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DEPARTMENT OF THE ARMY  
ST. LOUIS DISTRICT, CORPS OF ENGINEERS  
210 NORTH 12TH STREET  
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Earl Limpp Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Earl Limpp Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood
- 2) Overtopping could result in dam failure
- 3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: \_\_\_\_\_

Chief, Engineering Division

**SIGNED**

**18 SEP 1979**

Date

APPROVED: \_\_\_\_\_

Colonel, CE, District Engineer

**SIGNED**

**18 SEP 1979**

Date

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM

TABLE OF CONTENTS

<u>PARAGRAPH NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
	Assessment Summary	
	Overview Photograph	
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description of Project	1
1.3	Pertinent Data	2
	SECTION 2 - ENGINEERING DATA	
2.1	Design	5
2.2	Construction	5
2.3	Operation	5
2.4	Evaluation	5
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	6
3.2	Evaluation	8
	SECTION 4 - OPERATIONAL PROCEDURES	
4.1	Procedures	9
4.2	Maintenance of Dam	9
4.3	Maintenance of Operating Facilities	9
4.4	Description of Any Warning System in Effect	9
4.5	Evaluation	9
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	10
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	12
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	13
7.2	Remedial Measures	13

## APPENDIX A - MAPS

Plate A-1  
Plate A-2

Vicinity Topography  
Location Map

## APPENDIX B - PHOTOGRAPHS

Plate B-1	Photo Index
Plate B-2	Photo No. 2 - Upstream Slope
	Photo No. 3 - Crest From Right End
Plate B-3	Photo No. 4 - Gopher Hole Near $\frac{1}{2}$ Sta. 3+60
	Photo No. 5 - Transverse Crack
Plate B-4	Photo No. 6 - Downstream From $\frac{1}{2}$ Sta. 3+50
	Photo No. 7 - Downstream in Emergency Spillway
Plate B-5	Photo No. 8 - Gully Erosion
	Photo No. 9 - Boil and Seepage
Plate B-6	Photo No. 10 - Discharge From Boil
	Photo No. 11 - Downstream Slope Showing Gully Erosion
Plate B-7	Photo No. 12 - Seepage
	Photo No. 13 - Upstream From Left Side
Plate B-8	Photo No. 14 - Principal Spillway Inlet
	Photo No. 15 - Upstream From $\frac{1}{2}$ Sta. 3+00
Plate B-9	Photo No. 16 - Longitudinal Cracks
	Photo No. 17 - Downstream Road Structure
Plate B-10	Photo No. 18 - Inlet Riser For Road Structure
	Photo No. 19 - Upstream From Road Structure Dam in Background

## APPENDIX C - PROJECT PLATES

Plate C-1	Phase I - Plan and Centerline Profile of Dam
Plate C-2	Phase I - Section of Dam, Profile and Section of Spillway

## APPENDIX D - HYDRAULIC AND HYDROLOGIC DATA

Plates D-1 & D-2	Hydrologic Computations
Plate D-3	Emergency Spillway Rating Curve
Plate D-4	Combined Dam Rating Curve
Plate D-5	Ratio of PMF - Discharge Curve
Plates D-6 to D-18	Computer Input and Output for $1/2$ PMF

PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Earl Limpp Dam
State Located	Missouri
County Located	Holt County
Stream	Tributary Davis Creek
Date of Inspection	May 16, 1979

Earl Limpp Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

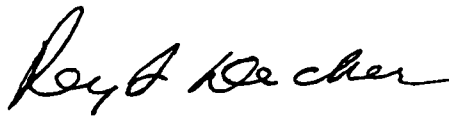
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately three and one-half miles downstream of the dam. Within the damage zone are a county road, a railroad, State Highway 275 and 5 to 10 buildings in Mound City.

Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the large floodplain downstream of the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will not pass the 100-year flood (flood having a one percent chance of being exceeded in any year) without overtopping the dam. The spillways will pass 12% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

No design data were available for this dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other deficiencies observed during the inspection are a large rodent hole, drying cracks in the crest, minor surface and gully erosion of the downstream slope and in the left abutment trough, seepage emerging near the stilling basin of the principal spillway, a boil on the right side of the stilling basin, an accumulation of trash and logs around the riser of the principal spillway, erosion of the stilling basin, lack of a trash rack on the riser of the principal spillway and a steel mesh fence crossing the emergency spillway.

Maintenance and repair items needed to be done by the owner are described in detail in the report.



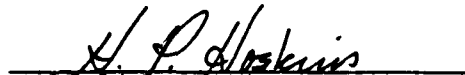
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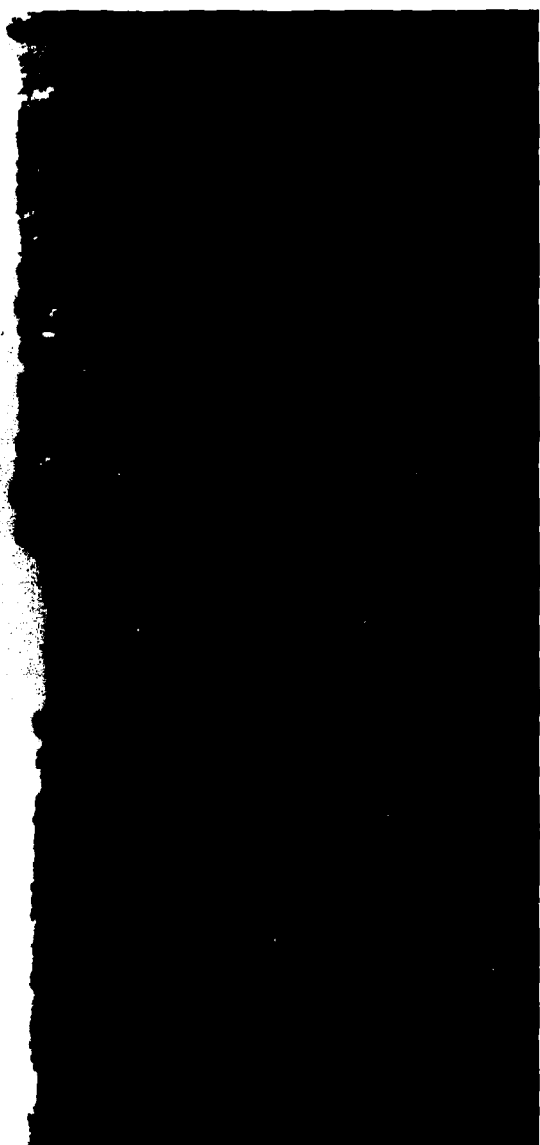


PHOTO NO. 1 - OVERVIEW FROM HIGH ON LEFT ABUTMENT

PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM  
EARL LIMPP DAM - MO 10508  
HOLT COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Earl Limpp Dam be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams," dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
  - (1) The dam is a small earth fill located in the loess hills of northwestern Missouri just east of Mound City. The dam is approximately 580 feet in length and 26 feet in height.
  - (2) The principal spillway consists of a 48 inch diameter corrugated metal pipe (CMP) riser connected with a 30 inch diameter CMP outlet conduit passing through the embankment.
  - (3) A vegetated earth emergency spillway with bottom width of 25 feet  $\pm$  is cut into the left abutment.
  - (4) Pertinent physical data are given in paragraph 1.3 below.

- b. Location. The dam is located in the east central part of Holt County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the SW $\frac{1}{4}$  of Section 35, T62N, R38W. The lake formed behind the dam is shown in the SW $\frac{1}{4}$  of Section 35, T62N, R38W.
- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph 1.1c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends approximately three and one-half miles downstream of the dam. Within the damage zone are a county road just downstream from the dam, railroad and Highway 275 and 5 to 10 buildings in Mound City.
- e. Ownership. The dam is owned by Earl Limpp, Mound City, Missouri 64470.
- f. Purpose of Dam. The dam is a flood retardation structure. It is one of 21 small dams constructed in the Davis Creek Watershed for flood protection in Mound City.
- g. Design and Construction History. This dam was constructed in 1972 as part of a group flood control project sponsored by the Agricultural Stabilization and Conservation Service (ASCS). It was reported that it was staked out by a technician from the ASCS. The Owner reported that a cutoff trench was not excavated for the dam but that standard corrugated metal antiseep collars were installed on the CMP spillway conduit.
- h. Normal Operating Procedure. There are no operating procedures for this dam. All spillways are uncontrolled.

### 1.3 PERTINENT DATA

- a. Drainage Area. 733 acres (1.145 square miles).
- b. Discharge At Damsite.
  - (1) All discharges at the damsite are through a principal spillway consisting of a 48 inch diameter corrugated metal riser connected with a 30 inch diameter corru-

gated metal outlet pipe and a grassed earth channel  
ungated emergency spillway.

- (2) Estimated maximum flood - unknown.
- (3) The principal spillway capacity varies from 0 c.f.s. at elevation 979.7 to 64 c.f.s. at elevation 983.1 (crest of the emergency spillway) to 69 c.f.s. at elevation 985.4 (minimum top of dam).
- (4) The emergency spillway capacity varies from 0 c.f.s at its crest elevation 983.1 feet to 194 c.f.s at elevation 985.4 (minimum top of dam) to 1070 c.f.s at elevation 987.8 (maximum top of dam).
- (5) Total spillway capacity at the minimum top of dam is 263 c.f.s  $\pm$ .

c. Elevations. (Feet above M.S.L.)

- (1) Top of dam - 986 to 988  $\pm$
- (2) Principal spillway crest - 980
- (3) Emergency spillway crest - 983
- (4) Streambed at centerline - 961  $\pm$
- (5) Maximum tailwater - unknown

d. Reservoir. Length (feet) of maximum pool - 2000  $\pm$ .

e. Storage (Acre-feet).

- (1) Top of dam - 283  $\pm$ .
- (2) Principal spillway crest - 146  $\pm$ .

f. Reservoir Surface (Acres).

- (1) Top of dam - 24  $\pm$ .
- (2) Principal spillway crest - 14  $\pm$ .

g. Dam.

- (1) Type - Earth fill.
- (2) Length - 580 feet  $\pm$ .
- (3) Height - 26 feet  $\pm$ .
- (4) Top width - 17 feet
- (5) Side slopes.
  - (a) Downstream - 3H on 1V (measured)
  - (b) Upstream - Exposed=3.8H on 1V (measured)
- (6) Zoning - unknown

- (7) Impervious core - unknown
- (8) Cutoff - unknown - owner reported none
- (9) Grout curtain - unknown
- (10) Wave protection - none

h. Diversion Channel and Regulating Tunnel. None

i. Spillway.

(1) Principal

- (a) Type - Corrugated metal pipe. 48 inch diameter riser approximately 6 feet high connected with 30 inch diameter CMP conduit outlet.
- (b) Crest (invert) elevation - Riser crest=980 feet,  
Conduit inlet=974 feet  $\pm$ .  
Outlet - 965.7 feet  $\pm$
- (c) Length - 112 feet  $\pm$

(2) Emergency

- (a) Type - vegetated earth, trapezoidal section
- (b) Control section approximately 40 feet in length with 25 feet  $\pm$  bottom width.
- (c) Crest elevation - 983 feet  $\pm$
- (d) Upstream Channel - vegetated, clear, approximately 35 feet in length on 7%  $\pm$  slope.
- (e) Downstream Channel - vegetated and clear to the creek. Few large trees in the old creek channel.

j. Regulating Outlets. None

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

No design data were available for this dam.

### 2.2 CONSTRUCTION

No construction data were available. It was reported by Earl Limpp, the Owner, that the dam was constructed in 1972.

### 2.3 OPERATION

No data were available on spillway operation.

### 2.4 EVALUATION

- a. Availability. No data were available.
- b. Adequacy. The field surveys and visual observation presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. Not applicable.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

- a. General. A visual inspection of the Limpp Dam was made on May 16, 1979. Engineers from Hoskins-Western-Sonderregger, Inc., Lincoln, Nebraska, making the inspection were: R. S. Decker, Geotechnical; Gordon Jamison, Hydrology; Garold Ulmer, Civil Engineer. Mr. Earl Limpp, the owner, was present during the inspection.
- b. Dam.
  - (1) Geology and Soils (Abutment and embankment). The dam is located in the deep loess rolling hills of north-western Missouri adjacent to the Missouri River. Upland soils are deep silty clay loam (CL-ML) loess. Abutment soils consist of a thin mantle of CL loess underlain by clay (CL-CH) glacial till. Valley alluvium is CL-ML material. Drying cracks in the embankment indicate that the material is moderately plastic CL, probably borrowed from the side slopes around the reservoir.
  - (2) Upstream Slope. The upstream slope is well vegetated with adapted grasses. No abnormal deformation nor significant erosion was observed on the upstream slope.
  - (3) Crest. The crest of the dam is well vegetated with adapted grasses. The embankment and reservoir area is used for cattle grazing and cattle trails across the dam are well worn. A large rodent hole was observed near Q Station 2+50 (see Photo 4). Longitudinal drying cracks were observed on the crest. A series of transverse (normal to the Q) cracks was observed at about Q Station 2+70 just left of the principal spillway location. The cracks were approximately 1/4 inch wide. Depth of cracks is not known. The transverse cracks were approximately 10 feet in length. The longitudinal cracks extended from Station 3+50 to Station 3+75+. The crest line profile is quite irregular with a low spot on the right end and high spot near Q Station 4+50.
  - (4) Downstream Slope. The downstream slope is well vegetated with adapted grasses. It is used for grazing and has a number of erosional rills and washes due probably, in part, to grazing when wet. Surface erosion is significant in the area downstream from stations 2+00 to about 3+00. A small seepy area was noted at the toe of the dam opposite about

Q Station 3+20. Several seeps were observed around the scour hole or stilling basin of the principal spillway. These seeps outcrop at or near the water line of the plunge pool. One small boil was observed on the right side of the plunge pool. It emerges through well aggregated, erosion resistant CH till. Flow from the boil was estimated at 0.1 gal./min. Total seepage effluent around the plunge pool probably amounts to 0.2 to 0.25 gals./min. All seepage was clear. No abnormal deformations were noted on the downstream slope.

The scour hole or plunge pool appeared to be eroded into fine grained glacial till.

- (5) Miscellaneous. The gully erosion noted on the downstream slope and in the left abutment trough and the transverse cracks across the top of the dam near the crossing of the principal spillway indicate that prolonged overtopping of this dam could cause potential of failure. Minor overtopping as caused by the 100-year flood would probably not cause significant damage to the structure.

c. Appurtenant Structures.

- (1) The Principal Spillway. The principal spillway consists of a 48 inch CMP riser with 30 inch CMP conduit outletting into a scour hole or plunge pool eroded into the valley bottom materials or into till. No corrosion or deterioration was noted in the metal pipe. The riser inlet does not have an effective trash rack and a considerable amount of trash and logs has accumulated around the riser (see Photo 14). The plunge pool and outlet channel appear to be stable.
- (2) The Emergency Spillway. The emergency spillway is cut into glacial till in the left abutment of the dam. It is well vegetated and appears to be stable. A steel mesh fence crosses the spillway downstream from Q of dam. Under high flows this fence could become clogged with debris and reduce the effectiveness of the spillway. No debris was noted in the spillway at the time of the inspection thus indicating very little or no flow through the emergency spillway. The inlet section is clear and well vegetated.

(3) Drawdown Facilities. There are no drawdown facilities for this dam.

- d. Reservoir Area. A few trees were observed in the upper end of the reservoir. No significant shore line erosion was observed.
- e. Downstream Channel. The channel downstream from the principal spillway has a number of trees growing along the bank. It appears to be stable and adequate to handle principal spillway discharges. Discharges from this structure will be temporarily impounded behind a road structure located about 300 feet downstream as described in Section 5 of this report.

### 3.2 EVALUATION

The dam appears to be in good condition except for the rodent hole on the crest and minor surface erosion noted on the downstream slope and along the central toe area. The 3H on 1V side slopes should provide adequate safety against shear failure. Foundation seepage at the toe and into the plunge pool does not appear to seriously impair the integrity of the structure. The transverse cracks adjacent to the principal spillway crossing probably indicate some differential settlement in the area of the old channel. However, none of these cracks were evident on the upstream or downstream slopes and there is a good chance that they have healed themselves on the interior of the dam. Spillway operations would be improved with removal and prevention of trash accumulations around the principal spillway riser and removal or replacement of the barrier fence across the emergency spillway.

Additional studies would be required to assess potential damage to the structure from overtopping.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, evaporation, and the capacity of the uncontrolled spillways.

### 4.2 MAINTENANCE OF DAM

Vegetation cover is well maintained by grazing activities. Some maintenance measures are needed to eliminate rodent holes, and reduce surface erosion on the downstream slope, and keep spillway inlets free of trash and debris.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

Upon checking with the owner, we are not aware of any emergency warning system for this dam.

### 4.5 EVALUATION

There does not appear to be any serious potential of failure of this structure. However, the minor surface erosion, foundation seepage, and transverse cracks discussed in Section 3.2 could lead to potential of failure if left unrepaired.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

- a. Design Data. No design data were found for this dam. All computations are based on the field inspection and survey performed by the consultant. The plans, profiles, and cross sections from the survey are attached in Appendix C.
- b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Maitland, Missouri 15 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection.
- c. Visual Observations.
  - (1) The spillway pipe appeared to be in good condition. There was no effective trash rack to speak of. Debris was accumulated around the riser, but the riser was open and operating.
  - (2) The emergency spillway and exit channel are located in the left abutment of the dam. Spillway releases should not endanger the integrity of the dam.
  - (3) The downstream channel appeared fairly open with some trees on the edge of the channel.
  - (4) A road embankment with a drainage structure through it is located a short distance downstream of the dam. The drainage structure is a 48 inch diameter corrugated metal pipe riser inclined approximately 60% from ground level. The culvert has no effect on the hydraulic operation of the principal spillway. The road is about 9 feet above the present water surface.
  - (5) No drawdown facilities are available to evacuate the pool.
- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood and the 100-year frequency flood without overtopping. The spillways will pass 12% of the PMF without overtopping. Prolonged overtopping could cause failure of this dam. The results of the routings through the dam are tabulated in regards to the following conditions.

<u>Frequency</u>	<u>Inflow Discharge c.f.s.</u>	<u>Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 985.4</u>	<u>Time Dam Overtopping Hr.</u>
10 Yr.	1300	80	983.9	+1.5	0
100 Yr.	2400	480	986.0	-0.6	2±
1/2 PMF	4700	4500	988.1	-2.7	6+
PMF	9300	9000	989.0	-3.6	9+
0.12 PMF	1075	263	985.4	0	0

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the 1/2 PMF to the PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in Paragraph 1.2d in this report.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observation. This dam appears to be structurally stable. The 3H on 1V side slopes would provide adequate safety against shear failures for a dam of this height. Seepage effluent is discharging at a rate of approximately 0.1 to 0.2 gallons per minute through erosion resistant materials and is all clear. Additional studies would be required to determine the affects of seepage pressures on structural stability under full loading conditions.
- b. Design and Construction Data. No design or construction data were available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.
- c. Operating Records. There are no controlled operating facilities for this dam.
- d. Post Construction Changes. The inspection team is not aware of any post construction changes for this structure.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of the magnitude predicted in this area is not expected to cause structural failure of this dam.

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

- a. Safety. The spillways will not pass 50% of the probable maximum flood. Additional studies would be required to determine the affect of overtopping on the safety of the dam. It would appear that prolonged overtopping could cause potential of failure. It appears that the structure is structurally stable but additional studies would be required to determine the affects of full reservoir loadings on seepage pressures and slope stability. The lack of some minor maintenance measures discussed in paragraph 7.2, do not pose a serious potential of failure but would enhance spillway operations and safety of the downstream slope.
- b. Adequacy of Information. Due to the lack of engineering data, the conclusions in this report are based upon performance history and visual observations. Seepage and stability analyses comparable to the requirements of the guidelines were not available which is considered a deficiency.
- c. Urgency. The item recommended in paragraph 7.2a should be pursued on a high priority basis.
- d. Necessity for Phase II. Phase II investigation is not considered necessary.
- e. Seismic Stability. This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

### 7.2 REMEDIAL MEASURES

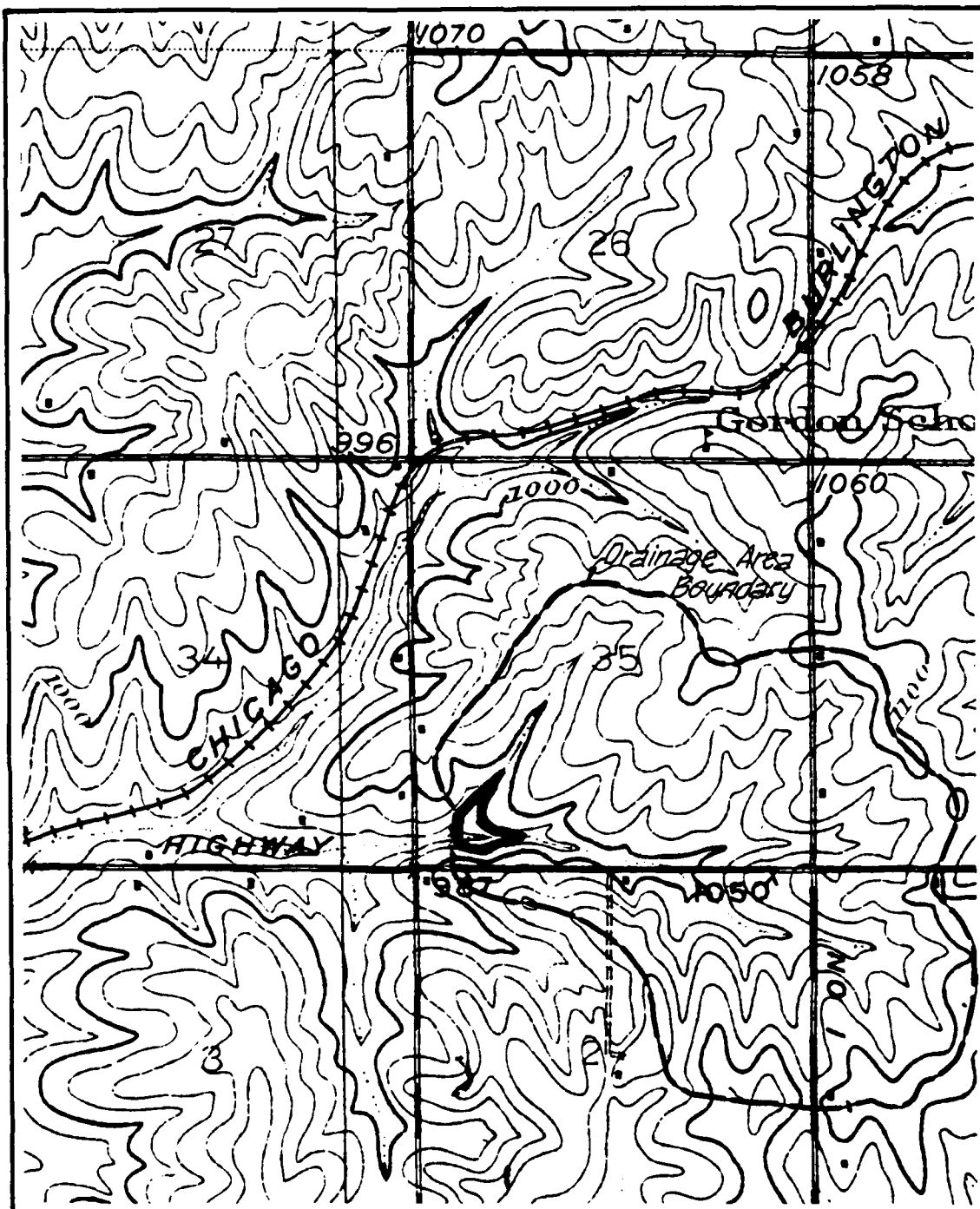
- a. Alternatives.
  - (1) Additional information should be obtained on the topographic characteristics of the reservoir area to determine the increase in the height of dam or the size of the spillway that is necessary to pass one half the probable maximum flood without overtopping the dam. The services of an engineer experienced in the design of dams should be obtained to evaluate the present reservoir storage capacity, to

provide seepage and stability analyses of the present dam, and to design protective measures, if required.

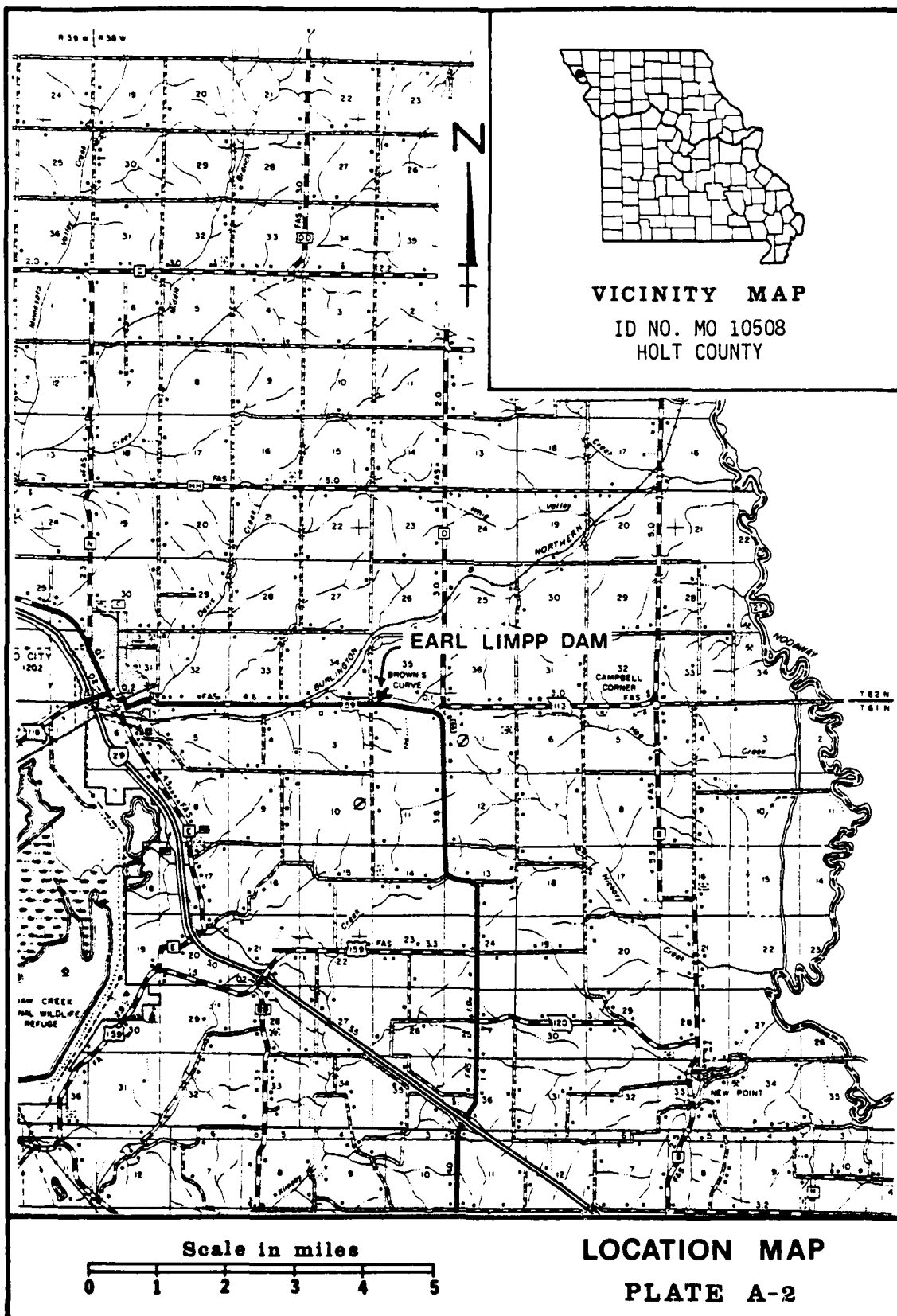
b. O & M Procedures.

- (1) Rodent holes should be eliminated and surface erosion in the left abutment trough and on the downstream slope should be repaired and measures initiated to minimize their recurrence. Elimination of the rodent holes should be done under the guidance of a qualified engineer.
- (2) Debris should be removed from the principal spillway riser and a trash rack and anti-vortex device should be installed on the riser.
- (3) The barrier across the emergency spillway should be removed or replaced with something that will not collect and accumulate trash and debris.
- (4) A program of regular inspection and maintenance should be initiated. The program should include observations and related maintenance measures connected with rodent activity, surface erosion on the downstream slopes of the dam and enlargement or development of transverse cracks on the crest of the dam near the location of the principal spillway.

APPENDIX A  
MAPS

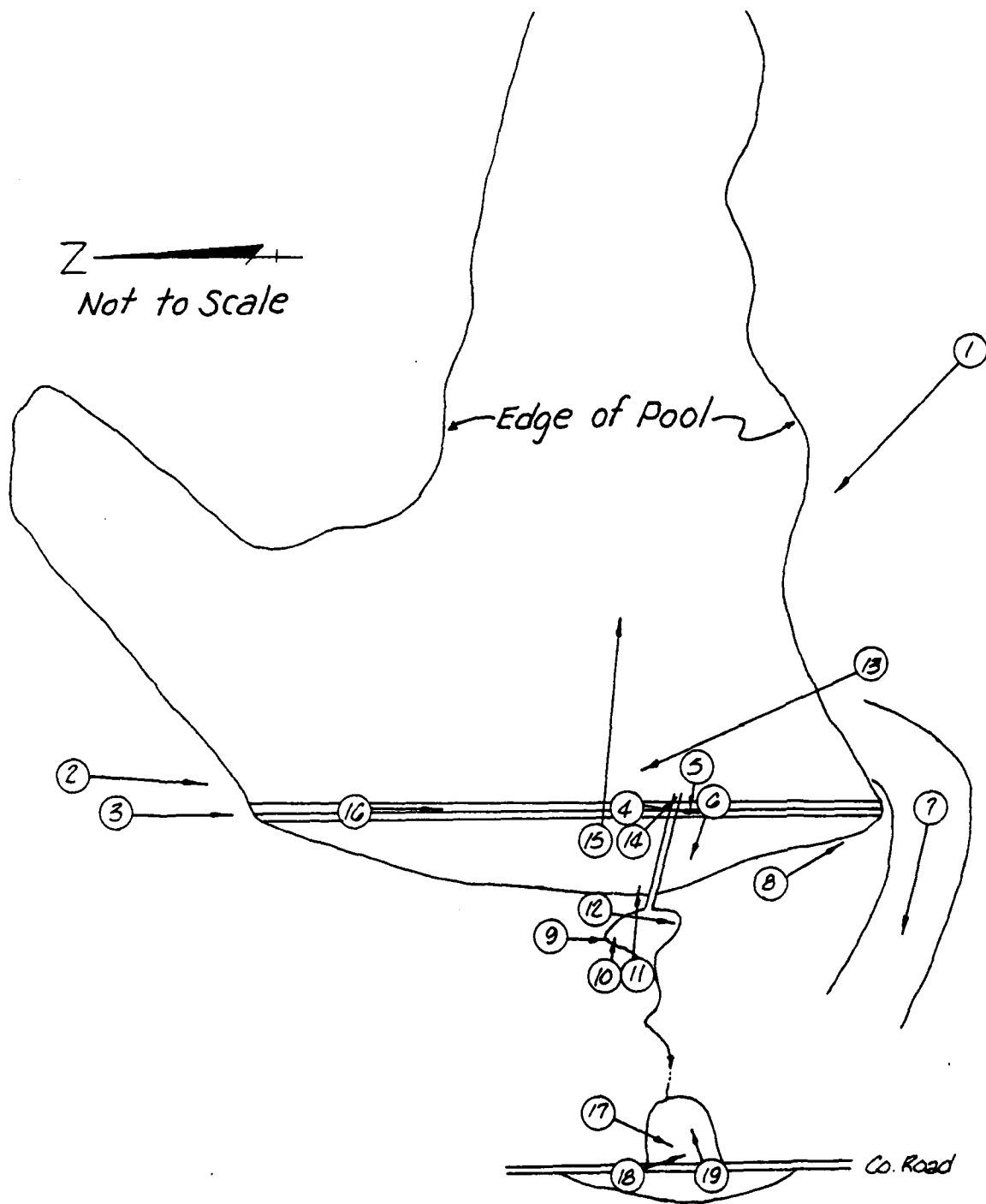


<p>Scale in feet</p> <p>2000 1000 0 2000 4000</p> <p><i>Contour Interval 20 Feet</i></p>	<p>N</p> <p><b>VICINITY TOPOGRAPHY</b></p> <p>EARL LIMPP DAM</p> <p>HOLT COUNTY, MISSOURI</p> <p>MO. 10508</p> <p>PLATE A-1</p>
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APPENDIX B  
PHOTOGRAPHS

Z ———+  
Not to Scale



## PHOTO INDEX

EARL LIMPP DAM

HOLT COUNTY, MISSOURI

MO. 10508

PLATE B-1



PHOTO NO. 2 - UPSTREAM SLOPE FROM RIGHT ABUTMENT



PHOTO NO. 3 - CREST FROM RIGHT END

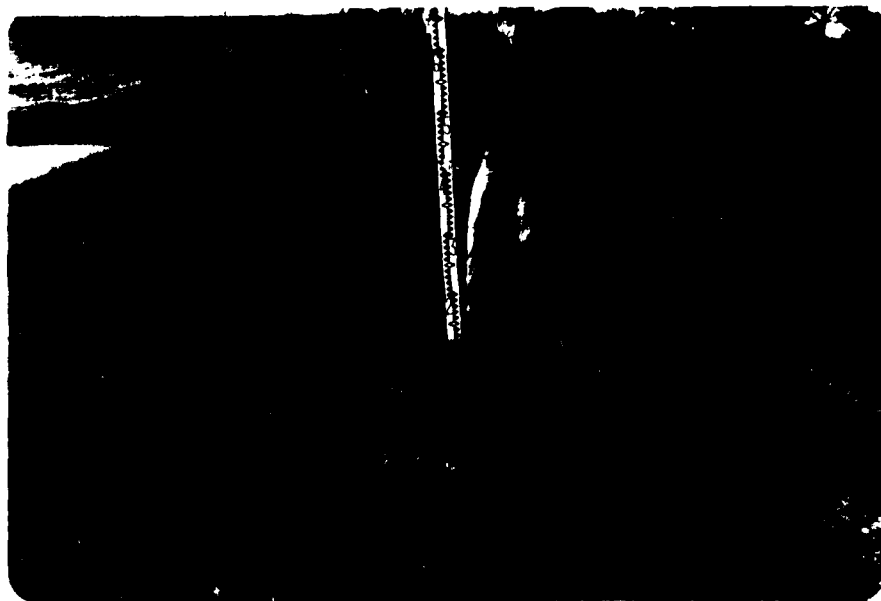


PHOTO NO. 4 - GOPHER HOLE NEAR  $\frac{1}{2}$  STA. 2 + 50. SURVEY ROD  
SETTING IN HOLE.



PHOTO NO. 5 - TRANSVERSE CRACK ACROSS CREST LEFT OF PIPE  
SPILLWAY CROSSING

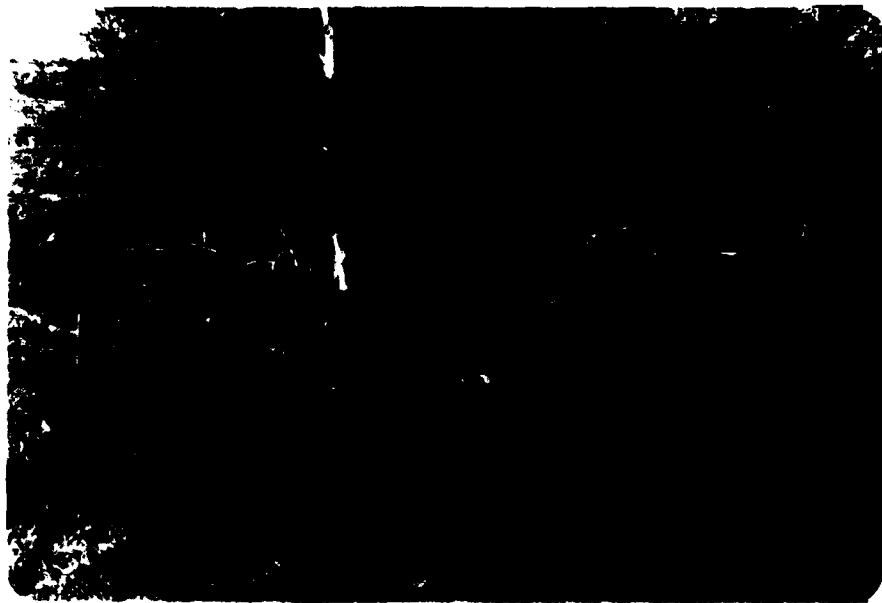


PHOTO NO. 6 - DOWNSTREAM FROM C STA. 3 + 50



PHOTO NO. 7 - LOOKING DOWNSTREAM IN EMERGENCY SPILLWAY



PHOTO NO. 8 -  
GULLY EROSION IN LEFT  
ABUTMENT TROUGH



PHOTO NO. 9 - BOIL AND SEEPAGE ON RIGHT SIDE OF SPILLWAY  
SCOUR HOLE

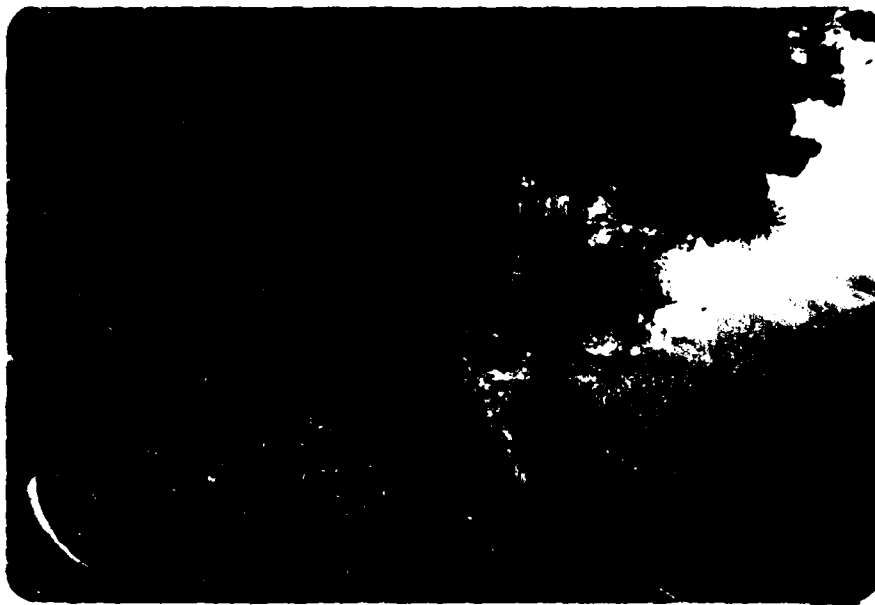


PHOTO NO. 10 - DISCHARGE FROM BOIL ON LEFT SIDE OF SCOUR HOLE



PHOTO NO. 11 - DOWNSTREAM SLOPE FROM DOWNSTREAM SHOWING GULLY EROSION



PHOTO NO. 12 - SEEPAGE ON LEFT SIDE OF SCOUR HOLE

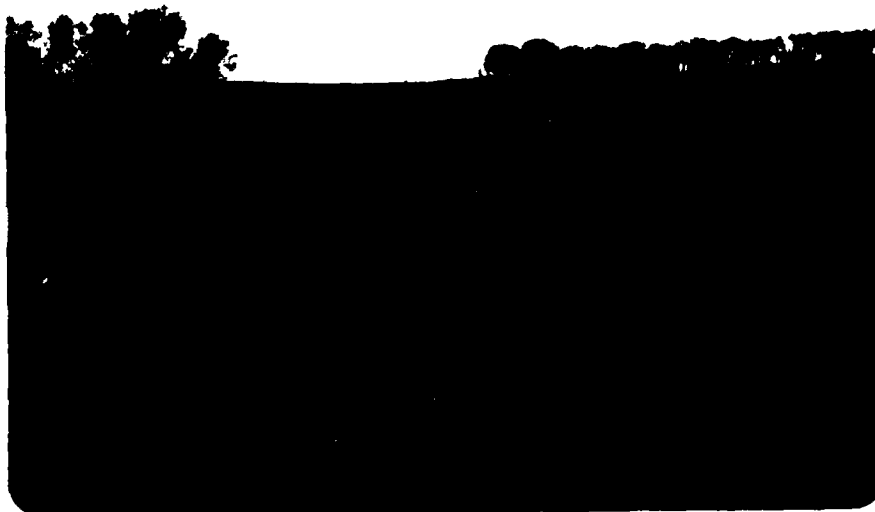


PHOTO NO. 13 - UPSTREAM FROM LEFT SIDE

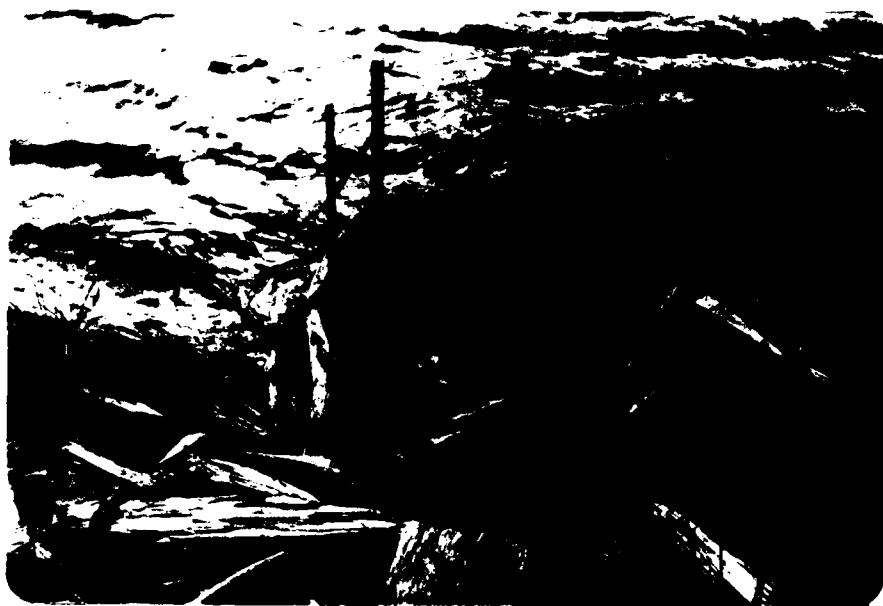


PHOTO NO. 14 - PRINCIPAL SPILLWAY INLET



PHOTO NO. 15 - LOOKING UPSTREAM FROM ABOUT  $\frac{1}{2}$  STA. 3 + 00



PHOTO NO. 16 - LONGITUDINAL CRACKS - C STA. 3 + 50 to 3 + 74.



PHOTO NO. 17 - ROAD STRUCTURE DOWNSTREAM FROM DAM



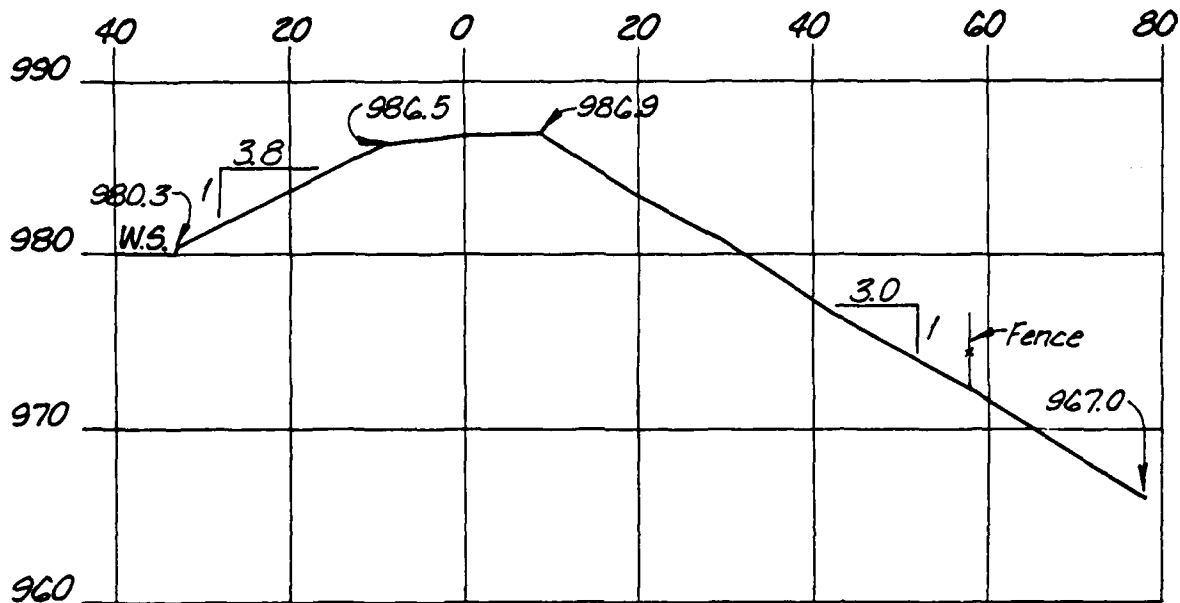
PHOTO NO. 18 - INLET RISER FOR ROAD STRUCTURE



PHOTO NO. 19 - LOOKING UPSTREAM FROM ROAD STRUCTURE. LIMPP DAM  
IN BACKGROUND

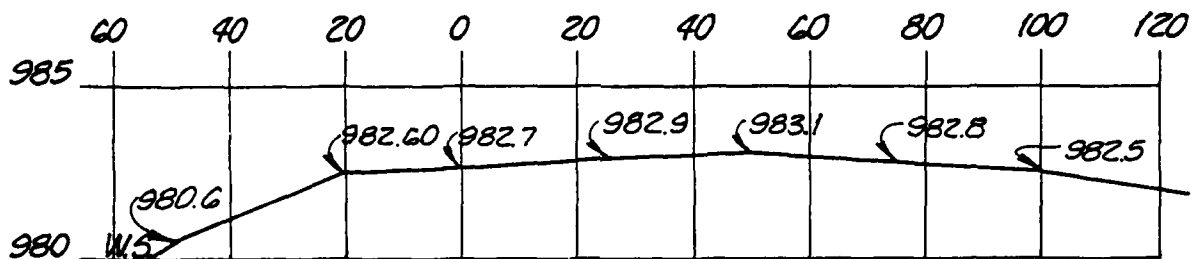
APPENDIX C  
PROJECT PLATES





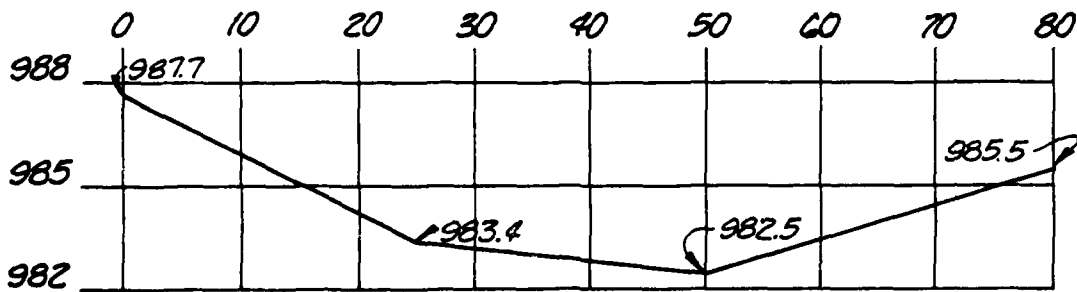
SECTION @ STA. 2+52

Scale : 1" = 20' H.  
1" = 10' V.



PROFILE OF SPILLWAY

Scale : 1" = 30' H.  
1" = 5' V.



SPILLWAY SECTION (C of DAM)

Scale : 1" = 15' H.  
1" = 5' V.

APPENDIX D  
HYDRAULIC AND HYDROLOGIC DATA

## HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (See Appendix D).

a. Twenty-four hour, 100-year and 10-year rainfall for the dam location were taken from the data for the rainfall station at Maryville, Missouri as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and Guidance for hydraulics and hydrology.

b. Drainage area = 1.145 square miles (733 acres).

c. Time of concentration of runoff = 35 minutes (computed from "Kirpich" formula).

d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the 100-year and 10-year precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.

e. The total twenty-four hour storm duration losses for the 100-year storm were 2.86 inches. The total losses for the PMF storm were 1.58 inches. These data are based on SCS runoff curve No. 88 and No. 75 for antecedent moisture conditions SCS AMC III and AMC II respectively. The watershed is composed of primarily SCS soil group B (Marshall, Shelby, and Wabash Soils) and consists mostly of cropland.

f. Average soil loss rates = 0.07 inch per hour approximately (for PMF storm, AMC III).

2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway and the flow going over the top of the dam.

a. The principal spillway rating was developed by using the weir and full conduit flow equations.

1. Weir Flow equation ( $Q = CLH^{1.5}$ )  
where  $C$  = weir coefficient = 3.1  
 $L$  = effective weir length, ft. = 12.57  
 $H$  = total head, ft.

2. Full conduit flow equation

$$Q = a \sqrt{\frac{2gH}{1 + K_e + K_b + K_p L}}$$

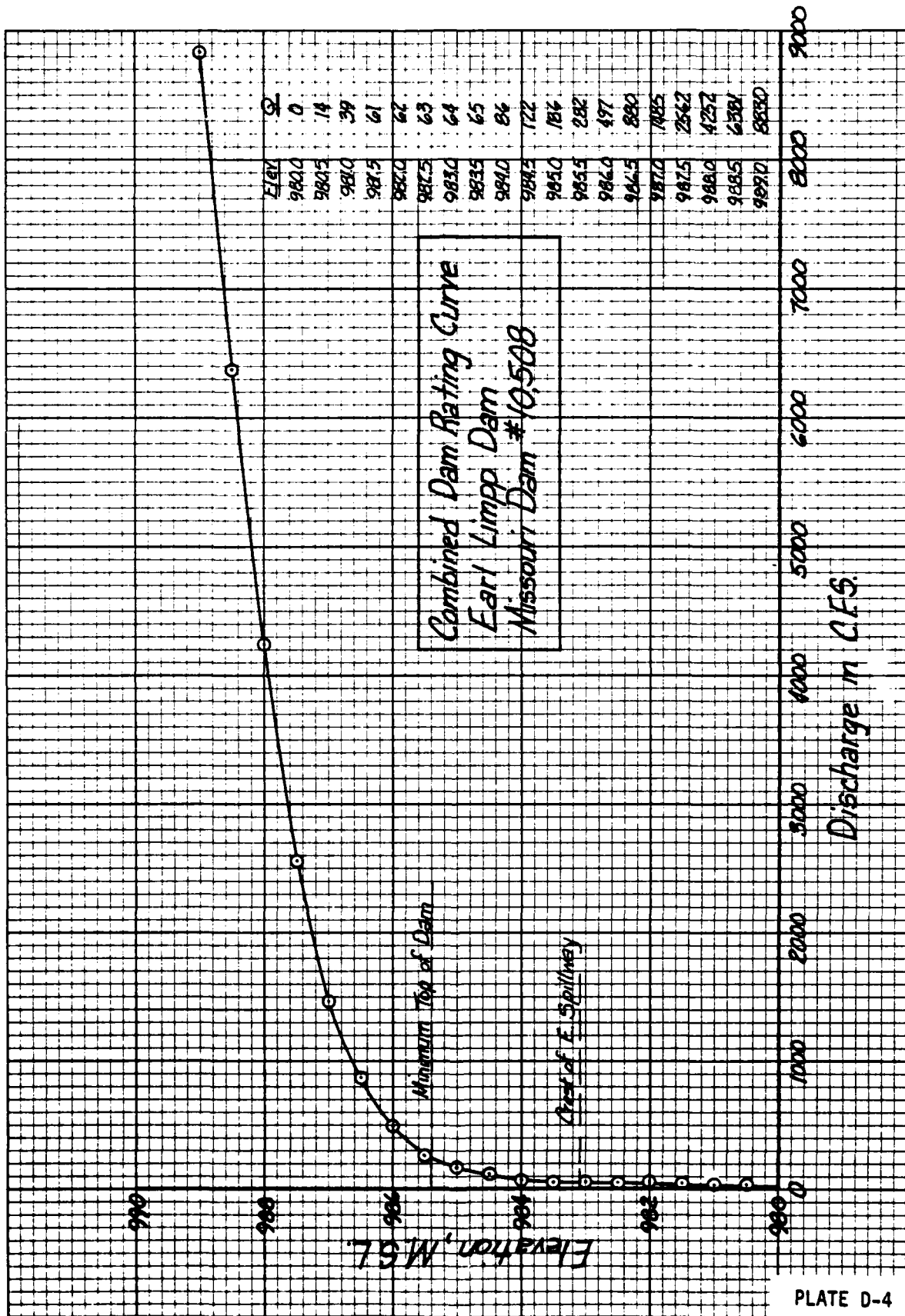
where  $a$  = cross-sectional area of pipe,  $\text{ft}^2 = 4.91$   
 $H$  = total head, ft.  
 $K_e$  = coefficient for entrance loss = 0.5  
 $K_b$  = coefficient for bend loss = 0.75  
 $K_p$  = coefficient for pipe friction loss = 0.0341  
 $L$  = length of pipe, ft. = 112

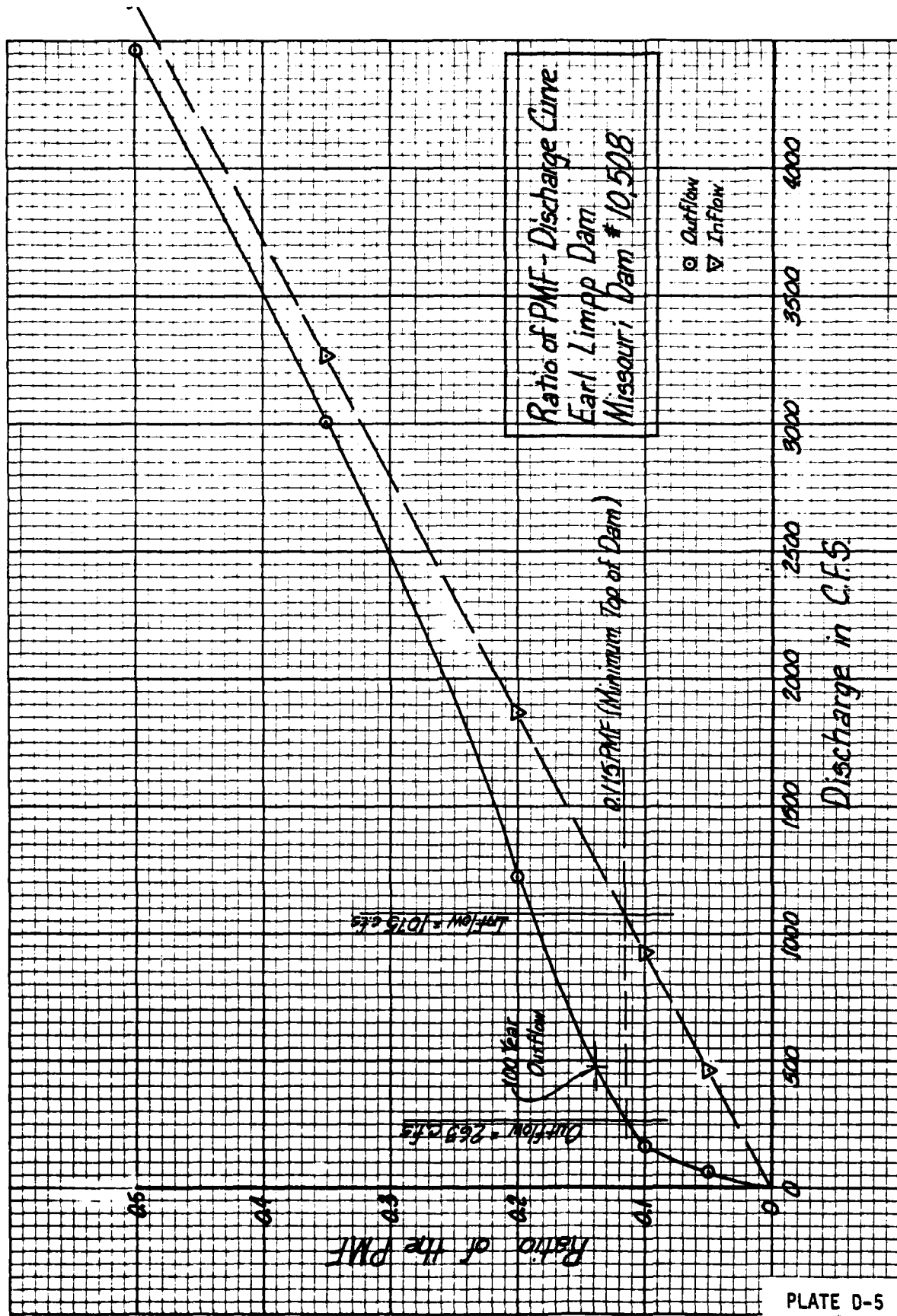
b. The emergency spillway rating curve was developed using the Corps of Engineers Surface Water Profile HEC-2 computer program.

c. The flows over the dam are based on the broad-crested weir equation ( $Q = CLH^{1.5}$ ) where  $H$  is the head on the dam crest,  $L$  is the effective length acting as a weir, and  $C$  is an appropriate weir coefficient which varies with head and is based on U.S. Geological Survey criteria. The weir coefficient  $C$  varied from 2.52 to 3.04 while the effective length varied from 20 to 100 feet depending upon the differences in the profile elevations.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input and output data sheets for the one-half PMF are attached as Appendix D.









\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 26 FEB 79  
 \*\*\*\*\*

RUN DATE 79/06/21  
 TIME 19.42.28.

# PMF Output Data

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF  
 HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF EARL LIMP DAM-10508  
 RATIOS OF PMF ROUTED THROUGH THE RESERVOIR

JOB SPECIFICATION											
NO	MMR	NRIN	IDAY	THR	ININ	METRC	IPIT	IPRT	INSTAN		
208	0	5	0	0	0	0	0	0	3	0	
			JOPEP	NWI	LROPT	TRACE					
		5	0	0	0	0					

MULTI-PLAN ANALYSES TO BE PERFORMED

ATDQ= .20 .35 .50 .65 .80 1.00  
 NPLAN= 1 NRTIO= 6 LRTIO= 1

## SUB-AREA RUNOFF COMPUTATION

CALCULATION OF INFLOW HYDROGRAPH TO 10508 RES

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000001	0	0	0	0	0	1	0	0

HYDROGRAPH DATA											
HYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISMOW	ISAME	LOCAL		
1	2	1.15	0.00	1.15	1.00	0.000	0	1	0		

PRECIP DATA					
SPFE	PMS	R6	R12	R24	R96
0.00	23.80	102.00	121.00	130.00	0.00

## LOSS DATA

LROPT	STKR	DLTKR	RTIOL	ERAIN	STKRS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-88.00	0.00	0.00

CURVE NO = -88.00 WETNESS = -1.00 EFFECT CN = 88.00

## UNIT HYDROGRAPH DATA

YC= 0.00 LAG= .35

## RECESSION DATA

SIRTO= 0.00 ORCSN= -.01 RTIOR= 1.00

UNIT HYDROGRAPH 23 END OF PERIOD ORIGINATES											
	153.	241.	170.	121.	85.	60.	43.	30.	21.	664.	987.
	481.	994.	1336.	1391.	1218.	987.	664.	30.	21.	664.	987.
	5.	2.	5.	43.	30.	21.	664.	30.	21.	664.	987.
	8.	5.	2.	43.	30.	21.	664.	30.	21.	664.	987.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4665.	1456.	450.	450.	129661.
CMS	132.	41.	13.	13.	3672.
INCHES		11.03	14.63	14.63	14.63
MM		300.43	371.62	371.62	371.62
AC-FT		722.	893.	893.	893.
THOUS CU M		890.	1101.	1101.	1101.

#### HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6065.	1893.	585.	585.	168559.
CMS	172.	56.	17.	17.	4773.
INCHES		15.38	19.02	19.02	19.02
MM		390.56	483.10	483.10	483.10
AC-FT		938.	1161.	1161.	1161.
THOUS CU M		1158.	1432.	1432.	1432.

#### HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7464.	2329.	720.	720.	207457.
CMS	211.	66.	20.	20.	5875.
INCHES		18.92	23.41	23.41	23.41
MM		480.68	594.59	594.59	594.59
AC-FT		1152.	1429.	1429.	1429.
THOUS CU M		1425.	1762.	1762.	1762.

#### HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9330.	2912.	900.	900.	259322.
CMS	264.	82.	23.	23.	7343.
INCHES		23.66	29.26	29.26	29.26
MM		600.86	743.23	743.23	743.23
AC-FT		1444.	1786.	1786.	1786.
THOUS CU M		1781.	2203.	2203.	2203.

#### HYDROGRAPH ROUTING

##### ROUTED FLOWS THRU 10508 RES

ESTAQ	ICOMP	TECON	ITAPE	JPLT	JPRY	INAME	ISTAGE	IAUTO
000002	1	0	0	0	0	1	0	0
QLOSS	CLOSS	AVG	IRF	IRF	IRF	IPMP	ISTR	
0.0	0.000	0.00	1	1	0	0	0	
HSTPS	NSTD	LAG	AMSK	X	TSK	STORA	ISRAI	

STAGE	1 0 0 0.000 0.000 0.000 -1									
	980.00	980.50	981.00	981.50	982.00	982.50	983.00	983.50	984.00	914.50
FLOW	0.00	14.00	39.00	61.00	62.00	63.00	64.00	65.00	66.00	122.00
	186.00	282.00	497.00	880.00	1485.00	2562.00	4252.00	6391.00	8830.00	
CAPACITY=	0.	146.	400.	788.	1370.	2573.	6167.			
ELEVATION=	960.	980.	990.	1000.	1010.	1020.	1040.			
	CREL	SPMID	COOM	EXPM	FLEVL	COQL	CAREA	EXPL		
	979.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
DAM DATA										
	TOREL	COOD	EXPD	DAHWD						
	985.4	3.0	1.5	0.						
STATION 000002, PLAN 1, RATIO 1										
END-OF-PERIOD HYDROGRAPH ORDINATES										
OUTFLOW										
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
4.	4.	5.	5.	6.	6.	7.	8.	9.	9.	9.
9.	10.	11.	11.	12.	12.	13.	14.	14.	14.	14.
18.	17.	18.	19.	20.	21.	22.	23.	24.	25.	25.
26.	27.	28.	29.	30.	31.	32.	33.	34.	34.	34.
35.	36.	37.	38.	39.	40.	41.	42.	43.	43.	43.
43.	44.	45.	46.	47.	47.	47.	48.	49.	49.	49.
50.	51.	52.	53.	54.	54.	54.	56.	58.	60.	60.
61.	61.	61.	62.	62.	62.	62.	62.	62.	62.	62.
63.	63.	63.	63.	63.	63.	64.	64.	64.	64.	64.
64.	65.	65.	67.	72.	77.	82.	87.	96.	104.	104.
112.	120.	132.	146.	159.	175.	199.	242.	320.	471.	471.
710.	936.	1140.	1223.	1220.	1167.	1089.	1001.	816.	532.	532.
805.	761.	722.	687.	657.	630.	605.	582.	560.	538.	538.
511.	498.	488.	479.	471.	463.	455.	447.	436.	422.	422.
402.	379.	353.	327.	300.	279.	268.	257.	246.	236.	236.
226.	216.	207.	198.	190.	183.	178.	173.	168.	164.	164.
159.	155.	151.	146.	143.	139.	135.	132.	128.	125.	125.
123.	120.	118.	117.	115.	113.	112.	110.	109.	107.	107.
106.	104.	103.	102.	100.	99.	98.	96.	95.	94.	94.
93.	91.	90.	89.	88.	87.	86.	85.	84.	84.	84.
86.	83.	82.	82.	81.	81.	80.	80.	80.	80.	80.
STORAGE										
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
146.	146.	146.	146.	146.	146.	146.	146.	146.	146.	146.
147.	147.	147.	147.	147.	147.	147.	147.	147.	147.	147.
147.	147.	147.	147.	147.	147.	147.	147.	147.	147.	147.

[illegible]



0000000002

STATION000002

INFLW(1), OUTFLOW(1) AND OBSERVED FLOW(1)	0.									
	0.	1000.	2000.	3000.	4000.	5000.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
.05	11									
.10	21									
.15	31									
.20	41									
.25	51									
.30	61									
.35	71									
.40	81									
.45	91									
.50	101									
.55	111									
1.00	121									
1.05	131									
1.10	141									
1.15	151									
1.20	161									
1.25	171									
1.30	181									
1.35	191									
1.40	201									
1.45	211									
1.50	221									
1.55	231									
2.00	241									
2.05	251									
2.10	261									
2.15	271									
2.20	281									
2.25	291									
2.30	301									
2.35	311									
2.40	321									
2.45	331									
2.50	341									
2.55	351									
3.00	361									
3.05	371									
3.10	381									
3.15	391									
3.20	401									
3.25	411									
3.30	421									
3.35	431									
3.40	441									
3.45	451									
3.50	461									
3.55	471									
4.00	481									
4.05	491									
4.10	501									
4.15	511									
4.20	521									
4.25	531									
4.30	541									
4.35	551									
4.40	561									

4.45 527  
4.50 581  
4.55 591  
5.00 601  
5.05 611  
5.10 621  
5.15 631  
5.20 641  
5.25 651  
5.30 661  
5.35 671  
5.40 681  
5.45 691  
5.50 701  
5.55 711  
6.00 721  
6.05 731  
6.10 741  
6.15 751  
6.20 7601  
6.25 7701  
6.30 7801  
6.35 7901  
6.40 8001  
6.45 8101  
6.50 8201  
6.55 8301  
7.00 8401  
7.05 8501  
7.10 8601  
7.15 8701  
7.20 8801  
7.25 8901  
7.30 9001  
7.35 9101  
7.40 9201  
7.45 9301  
7.50 9401  
7.55 9501  
8.00 9601  
8.05 9701  
8.10 9801  
8.15 9901  
8.20 1000.1  
8.25 101.01  
8.30 102.01  
8.35 103.01  
8.40 104.01  
8.45 105.01  
8.50 106.01  
8.55 107.01  
9.00 108.01  
9.05 109.01  
9.10 110.01  
9.15 111.01  
9.20 112.01  
9.25 113.01  
9.30 114.01  
9.35 115.01  
9.40 116.01  
9.45 117.01  
9.50 118.01





20.15243.10  
 20.20244.10  
 20.25245.10  
 20.30246.10  
 20.35247.10  
 20.40248.10  
 20.45249.10  
 20.50250.10  
 20.55251.10  
 21.00252.10  
 21.05253.10  
 21.10254.10  
 21.15255.10  
 21.20256.10  
 21.25257.10  
 21.30258.10  
 21.35259.10  
 21.40260.10  
 21.45261.10  
 21.50262.10  
 21.55263.10  
 22.00264.10  
 22.05265.10  
 22.10266.10  
 22.15267.10  
 22.20268.10  
 22.25269.10  
 22.30270.10  
 22.35271.10  
 22.40272.10  
 22.45273.10  
 22.50274.10  
 22.55275.10  
 23.00276.10  
 23.05277.10  
 23.10278.10  
 23.15279.10  
 23.20280.10  
 23.25281.10  
 23.30282.10  
 23.35283.10  
 23.40284.10  
 23.45285.10  
 23.50286.10  
 23.55287.10  
 0.00288.10

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO	1	RATIO	2	RATIO	3	RATIO	4	RATIO	5	RATIO	6
					.20		.35		.50		.65		.80		1.00
HYDROGRAPH AT	000001	1.15	1	1866.	3266.	4665.	6065.	7664.	9330.						
	(	2.97)	(	52.84)	92.47)	132.10)	171.73)	211.36)	264.20)						
ROUTED TO	000002	1.15	1	1223.	3009.	4460.	5848.	7232.	9050.						
	(	2.97)	(	34.64)	85.21)	126.29)	165.59)	204.79)	256.27)						

**PLAN I .....**

DATE RECEIVED: 10/10/2010

END

DATE  
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